PHYTOTOXICOLOGY ASSESSMENT SURVEYS CONDUCTED IN THE VICINITY OF CANADA BRICK, BURLINGTON, 1986, 1987 AND 1989

MARCH 1991

Ontario
Environment
Environnement

ISBN 0-7729-8065-9

92-01656/

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MARCH 1991

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log 90-2231-008
PIBS 1475

Phytotoxicology Assessment Surveys Conducted in the Vicinity of Canada Brick (CB), Burlington -1986, 1987 & 1989

Introduction

Surveys were conducted by the Phytotoxicolgy Section, Air Resources Branch, in August 1986, 1987, and 1989 in the vicinity of Canada Brick (CB), Burlington, to determine the effects of fluoride emissions on surrounding vegetation. The surveys were requested by the Ontario Ministry of the Environment Central region in consideration of the potential emissions created through expansion of brick production facilities by the company in late 1986 through mid-1987. Vegetation assessment surveys had previously been conducted in 1976 and 1977, when the plant was operated by Diamond Clay Products. The earlier surveys revealed that fluoride emissions from the kilns were of minor significance.

CB lies adjacent to the Bronte River Valley at its east and north boundaries. The west boundary borders CNR tracks and is neighboured to the immediate west by scrub land and commercial/industrial properties. Neighbouring the southern boundary were commercial and residential properties abutting on Dundas St. (see attached figure).

Sampling and Injury Assessment

In August each year, tree foliage sites close to the CB company as well as at more remote sites was collected for analysis. In 1986, foliage was collected from exposed middle branches of trees available at the 8 original sites (Sites 2, 3, 4, 6, 7, 8, 9 & 12) sampled in 1977. In addition, samples were collected from 5 new sites (Sites 1, 5, 11, 14 & 15). Also, in 1986, forage (grass) was collected from the closest hay field (Site 13) to the neighbouring southeast of CB, as well as from remote Site 10. All sites, except Sites 1, 2 and 3, were situated off company property (see attached figure). In 1987 and 1989, the above-noted sites were again sampled, with exception of the forage sites in 1989. Each year, duplicate samples were collected at each site using standard sampling procedures.

Also, during each annual survey, foliage of trees and other vegetation (e.g. wild grape), which is known to be sensitive to fluoride, growing in the vicinity of the collection sites was inspected for fluoride injury.

The samples collected each year were returned to the Phytotoxicology Section for processing. Here, the tree foliage samples were processed on an unwashed and washed basis. All samples, including the unwashed forage samples, then were submitted

on a dry weight basis to the MOE laboratory for analysis of fluoride.

Analytical Results

Attached Table 1 shows the 1986, 1987 and 1989 August fluoride results for the unwashed samples. Also shown are the corresponding 1977 results. In each year, tree foliage results displayed a decreasing pattern with distance from the company. The highest fluoride levels were detected at Site 7 (native scrub area) to the immediate west of the company, and at Sites 2 & 3 (on company property) to the immediate east to southeast. It is also apparent that foliar fluoride levels throughout the survey area were markedly increased in 1987 and 1989, following the company expansion program, as compared to the pre-expansion 1977/1986 levels. The yearly average fluoride level for the seven original (1977) sites neighbouring CB increased in 1987 (141 ppm) and 1989 (138 ppm) by about 2.5 to 1.4 times compared to the respective averages for 1977 (40 ppm) and 1986 (57 ppm).

In comparison to the Phytotoxicology Section Upper Limit of Normal (ULN) rural guideline for fluoride in foliage (15 ppm), most foliage sites had a fluoride level greater than the guideline in all years. The highest unwashed foliar levels detected in 1987 and 1989 (269 & 290 ppm) were 17 to 18 times higher than the 15 ppm ULN guideline. Upper Limit of Normal guidelines represent the expected maximum concentration of contaminants in foliage/leaves not subject to the influence of point sources of emissions. They were derived by taking the arithmetic mean of available analytical data from uncontaminated samples and adding three standard deviations of the mean. It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Concentration which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations which are below the guidelines would not normally be considered toxic.

Attached Table 2 shows the percent of fluoride (considered to be particulate) removed by washing from the tree foliage samples collected each year. These data show considerable variability between sites and years. It is also apparent that the degree of particulate deposition at several sites was greater in 1987 than in 1986. In 1987, five sites (Sites 2, 4, 6, 8 & 12) had a particulate removal value of about 50 % or higher. The removal values for 1989 were, in most cases, markedly reduced from 1987 levels. This information must also be considered in light of climatic data as discussed later in this report.

As shown in Table 1, the unwashed grass samples collected at Site 13 (near CB) also had an increased fluoride level in 1987 (20 ppm) relative to the corresponding 1986 (8 ppm) level. The grass fluoride levels found at Site 13 also were higher than those found at more remote Site 10 in 1987 (5 ppm) and 1986 (4 ppm). The grass

fluoride level of 20 ppm also slightly exceeded the corresponding 12 ppm ULN guideline, but did not exceed the 80 ppm MOE forage criterion for any single month. The MOE fluoride criteria for forage was developed to protect animal health; therefore, even the highest forage level of 20 ppm would not be expected to pose any health threat to grazing animals.

Injury Assessment Findings

Foliar inspections in 1986, 1987 and 1989, revealed injury typical of fluoride toxicity primarily on wild grape plants. The most severe injury to wild grape was observed to the immediate east, southeast and west of the company in the area of collection Sites 1, 2, 3 and 7 (Sites 1, 2, & 3 were located on company property). The overall severity of injury to wild grape near these sites was rated as light (2-10%) to moderate (11-35%) in 1987 and 1989, as compared to trace (>0-1%) to light in 1977 and 1986. In all years, wild grape plants at more remote sites (off company property) exhibited either trace or very light foliar injury overall, with exception of those near Site 4 in 1987 which had light to moderate injury. Wild grape injury in the survey area, as well as being generally more severe in 1987 and 1989, also appeared to be slightly more extensive, as compared to the earlier years. In 1987 and 1989, fluoride-like injury was observed on wild grape foliage through to the area of Sites 11 (960m SW) and 15 (700m E), where only a few grape leaves were found to have trace or inconsequential injury.

Foliar inspections in 1987 also revealed trace to light injury typical of fluoride on choke cherry foliage and on current year's Eastern white pine needles in the vicinity of Site 1. Silver maple collection Site 3 also exhibited some leaves with trace injury in 1986, 1987 and 1989, as did silver maple at Site 12 in 1989. Also, gladiolus plants at Site 5 exhibited some leaves with light injury in 1989. Sites 5 and 12 were situated on residential properties south of Dundas Street. Other vegetation inspected annually throughout the survey area did not display any foliar injury which was considered to be attributable to fluoride emission.

Weather Data and Discussion

Attached Table 3 shows the wind and rainfall data from the nearby Oakville southeast station for June through August in 1977, 1986, 1987, and 1989. During this period each year, winds prevailed from the northwest (NW) and west (W). The total % of NW and W winds (June through August) was slightly increased in 1987 (55%) from 1986 (52%) and was reduced in 1989 (46%). Table 3 also shows that the total rain received during June-August of 1987 was greater than in other years, because of the unusually high rainfall in July. Rainfall can have a washing effect and reduce fluoride levels in foliage. However, in 1987, unlike other years, weather conditions were dry during the 2 week period preceding the foliage collection.

This dry weather, together with the activities/operations related to the company's expansion program, likely contributed to the fairly high particulate removal levels found in 1987. Table 3 also shows that 1989 had less rainfall than the other years. However, in 1989, there was a heavy rain on the day preceding the collection, which likely contributed to the particulate removal values being reduced from the 1987 levels.

In light of the preceding information, it is unlikely that weather was a primary contributor to the 2 fold increase in foliar fluoride levels that occurred in the survey area in 1987 and 1989 relative to the earlier periods. Because the increase in vegetation fluoride levels followed the company expansion program, it is suspected that the increase was more directly related to CB emissions of fluoride having increased during 1987 and 1989.

Summary

In summary, the results of recent vegetation surveys indicate that the Canada Brick expansion program in 1986/1987 resulted in an increase in ambient fluoride emissions. Vegetation fluoride levels and foliar injury increased in the survey area in 1987 and 1989, with corresponding foliar levels being increased by about 2 times relative to pre-expansion (1977 & 1986) levels. The most adverse effects, as in earlier years (1977 & 1986), were confined to the immediate area of the company.

VEGETATION COLLECTION SITES IN THE VICINITY OF CANADA BRICK (CB), BURLINGTON - AUGUST 1986, 1987 & 1989

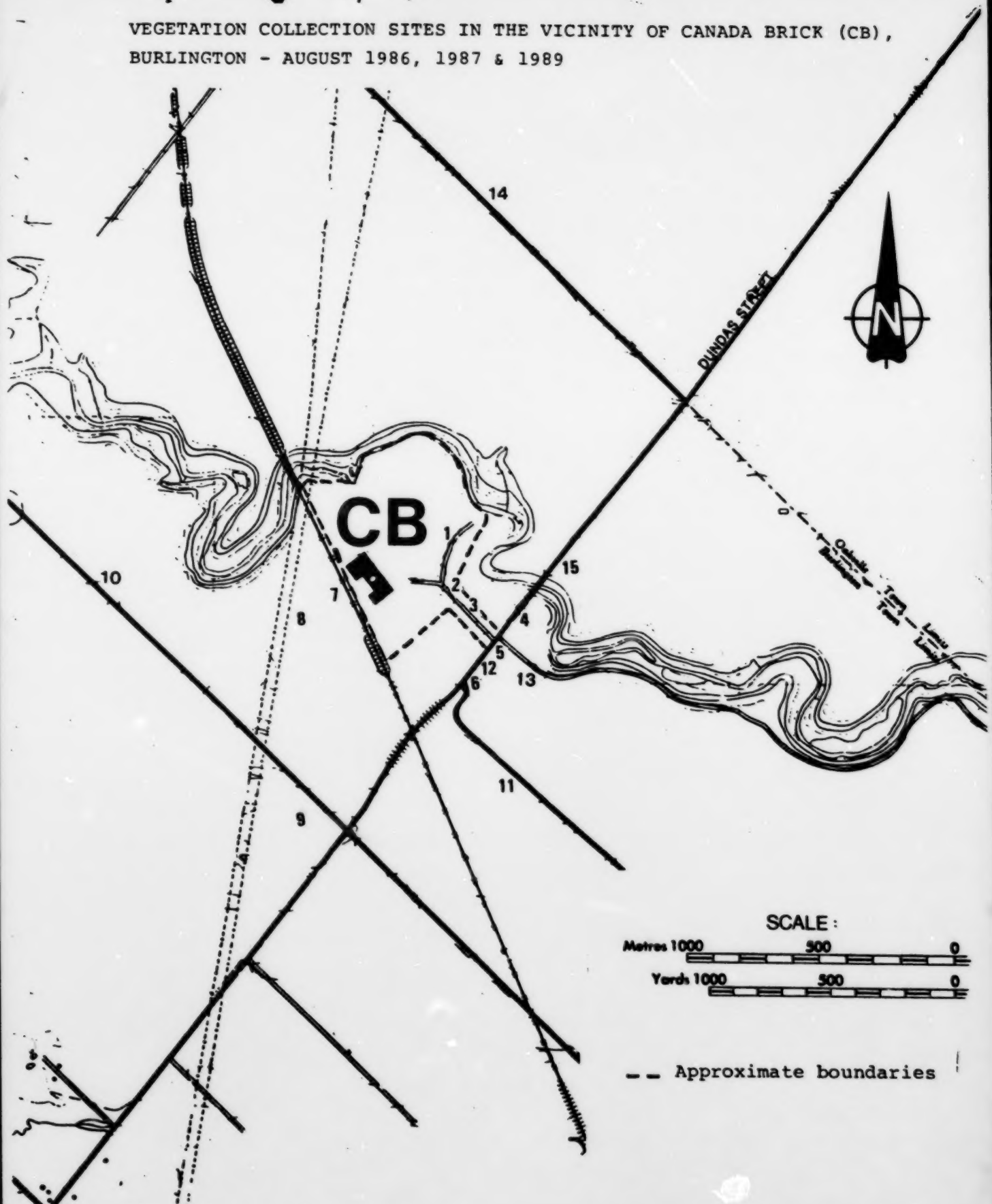

Table 1: Average Fluoride Concentration (ug/g, dry wt.) Detected in Unwashed Vegetation Collected in the Vicinity of Canada Brick (CB), Burlington - August 1977, 1986, 1987 & 1989

Site No.	Distance & Direction from CB	Foliage Type (M-maple)	* Year 1977	1986	1987	1989
		Sites Neighbouring CB				
1	350m NE	Sugar M	-	43	127	107
2	280m E	Sugar M	68	87	219	200
3	400m ESE	Silver M	52	70	229	160
4	550m ESE	Manitoba M	31	33	69	64
5	540m SE	Silver M	-	35	131	135
6	540m SE	Manitoba M	15	20	58	68
7	125m WSW	Apple	69	160	269	290
8	300m WSW	Sugar M	3	17	54	65
12	530m SE	Silver M	40	15	89	120
13	680m SE	Grass	-	8	20	-
15	700m E	Manitoba M	-	23	32	26
Mean of Neighbouring Sites**			40	57	141	138
		More Remote Sites				
9	960m SSW	Manitoba M	3	8	9	9
10	1025m W	Grass	-	4	5	-
11	960m SW	Silver M	-	12	13	26
14	1480m NNE	Sugar M	-	4	7	6

* 1986, 1987 and 1989 averages are based on duplicate sample results. Triplicate samples were collected in 1977

** Calculated on basis of seven sites sampled in 1977

Note: Sites 1, 2 and 3 are situated on company property

Table 2: Percent (%) Fluoride Removal* from the Tree Foliage Samples By Washing, Based on the Unwashed (NW) and Washed (W) Results - August 1977, 1986, 1987 & 1989

Site No.	Distance & Direction from CB	Foliage Type (M-maple)	Year 1977	1986	1987	1989
				(%)		
		Sites Neighbouring Canada Brick (CB)				
1	350m NE	Sugar M	-	21	31	-
2	280m E	Sugar M	49	24	46	20
3	400m ESE	Silver M	44	11	38	3
4	550m ESE	Manitoba M	35	0	48	-
5	540m SE	Silver M	18	17	36	26
6	540m SE	Manitoba M	20	25	60	32
7	125m WSW	Apple	17	17	36	-
8	300m WSW	Sugar M	0	41	52	-
12	530m SE	Silver M	-	0	62	30
15	700m E	Manitoba M	-	13	34	-
		More Remote Sites				
9	960m SSW	Manitoba M	0	25	33	-
11	960m SW	Silver M	-	42	15	-
14	1480m NNE	Sugar M	-	50	29	-

* Particulate removal values were calculated from the unwashed and washed average fluoride levels detected at each site using the following formula: $\frac{NW - W}{NW} \times 100$

Note: Sites 1, 2 and 3 are situated on company property

Table 3: Summary of Percentage of Wind Direction Occurrence from the West (W) and Northwest (NW) and Precipitation Data Recorded at the Oakville Southeast Station - June through August 1977, 1986, 1987 and 1989

	June		July		August*		June-August*		
				% Wind Direction					
Year	W	NW	W	NW	W	NW	W	NW	
1977				No wind data					
1986	24	29	22	27	29	26	25	28	
1987	31	25	31	23	30	26	31	24	
1989	25	19	17	24	32	28	23	23	
				Rainfall*** Total (T) & Frequency (F)					
Year	T	F	T	F	T	F	T	F	
1977	75	10	90	8	96	9	261	27	(8)
1986	74	12	96	11	84	9	254	32	(5)
1987	67	9	208	9	47	4	322	22	(0)
1989	83	13	68	6	44	7	195	26	(7)
** Normal	70	9	65	8	80 (full month)	8			

* Through to end of day preceding collection date: 1977 - August 19; 1986 - August 20; 1987 - August 27; 1989 - August 16

** Normals taken from Canadian Climate Normals, Atmospheric Environment Service, Environment Canada

*** Rain as millimeters; Frequency as number of days

( ) Number of days with rain during 14 day period prior to foliage collection